4.0 STREAM BOTTOM DEPOSITS

4.1 Summary

During the 1998 SWQB intensive water quality survey in the Upper Rio Chama Watershed, impairment of the aquatic community due to excessive stream bottom deposits (SBD) was documented at the lower sampling station on Rito de Tierra Amarilla (SWQB Station 16). Consequently, the Rito de Tierra Amarilla from Rio Chama to State Highway 64 was listed on the 2000-2002 Clean Water Act §303(d) list for SBD.

4.2 Endpoint Identification

Target Loading Capacity

Target values for this SBD TMDL will be determined based on 1) the presence of numeric criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. This TMDL is also consistent with New Mexico's antidegradation policy.

According to the New Mexico water quality standards (20.6.4.12.A NMAC), the general criterion for SBD reads:

> Bottom Deposits
>
> Surface waters of the state shall be free of water contaminants from other than natural causes that will settle and damage or impair the normal growth, function, or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.

The impact of fine sediment deposits is well documented in the literature. An increased sediment load is often the most important adverse effect of activities on streams, according to a monitoring guidelines report (USEPA 1991). This impact is largely a mechanical action that severely reduces the available habitat for macroinvertebrates and fish species that utilize the streambed in various life stages. Minshall (1984) cited the importance of substratum size to aquatic insects and found that substratum is a primary factor influencing the abundance and distribution of insects. Aquatic detritivores also can be affected when their food supply either is buried under sediments or diluted by increased inorganic sediment load and by increasing search time for food (Relyea et al., 2000).

The SWQB Sediment Workgroup evaluated a number of methods described in the literature that would provide information allowing a direct assessment of the impacts to the stream bottom substrate. As a result, SWQB/NMED compiled techniques to measure the level of sedimentation of a stream bottom in a SWQB/NMED draft Protocol for the Assessment of Stream Bottom Deposits in order to address the narrative criteria for SBD (SWQB/NMED 2001c). The purpose of the Protocol is to provide a reproducible quantification of the narrative criteria for SBD. A final set of monitoring procedures was implemented at a wide variety of sites during the 1998 monitoring season. These procedures included conducting pebble counts (to determine percent fines), stream bottom cobble embeddedness, geomorphologic measurements, and the collection and enumeration of benthic macroinvertebrates.

The target levels involved the examination of developed relationships between percent fines and biological score as compared to a reference site. Using existing data from New Mexico, a strong relationship (R^2=0.75) was established between embeddedness and the biological scores using data collected in 1998 (SWQB/NMED 2001c). A strong correlation (R^2= 0.719) was also found when relating embeddedness to percent fines. Although these correlations were based on a limited data set, TMDL studies on other reaches, including those in the Cimarron Basin, the Jemez Basin, and the Rio Guadalupe, have shown this relationship to be consistent. These relationships show that at the desired biological score of at least 70, the target embeddedness for fully supporting a designated use would be 45% and the target fines would be 20% (SWQB/NMED 2001c). Since this relationship is based on New Mexico streams, 20% was chosen for the target value for percent fines.

Rito de Tierra Amarilla at HWY 64 (SWQB station 15) was chosen as the benthic macroinvertebrate reference station for Rito de Tierra Amarilla at HWY 112 (SWQB station 16). They are both in ecoregion 21 and have similar geomorphic characteristics as displayed in Table 4.1 (see Appendix A for field data). Benthic macroinvertebrate samples and pebble counts were collected at both stations (Barbour et al. 1999, Wohlman 1954) (Photo 07).

Table 4.1 Geomorphic characteristics of benthic macroinvertebrate sampling sites

Dimensions	Station 15 (reference site)	Station 16 (study site)
x-section area (ft)	10.9	18.2
width (ft)	14.1	19.1
max depth (ft)	1.2	1.4
mean depth (ft)	0.76	1.0
width/depth ratio	18.6	20.0
entrenchment ratio	1.4	1.4

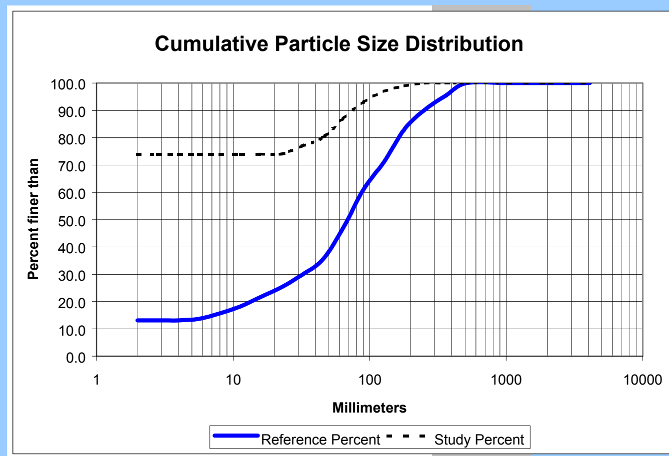
Collection of benthic macroinvertebrates involved the compositing of three individual kick net samples taken from a riffle at each sampling location. Each kick involved the disturbance of approximately one-third of a square meter of substrate for one minute into a 500-micron mesh net. The rapid bioassessment protocol metrics were applied to a 300-organism subsample of the composite sample at each site (Barbour et al. 1999). Selection of those metrics that are particularly suited to the delineation of sediment impacts highlights the degree of impairment. Ephemeroptera/ Plecoptera/ Tricoptera (EPT) Taxa, the number of sediment adapted organisms, taxa richness, and Hilsenhoff's Biotic Index (HBI) all indicate some degree of impairment attributable to sedimentation. Select results of the pebble count and benthic macroinvertebrate surveys are shown in Table 4.2 and Figure 4.1 (SWQB/NMED 2001a). See Appendix A for field data.

Table 4.2 Pebble count and benthic macroinvertebrate results

Results	Station 15 (reference)	Station 16 (study)	Percent of reference
Pebble count			
percent fines (< 2 mm)	26	74	285%
D50	69	na	
D84	186	55	
Benthic metrics			
Standing crop (#/m^2)	1480	133	
EPT taxa	20	5	
Taxa richness	30	18	
HBI	3.1	5.5	
Total biologic score	58	24	41%
Total habitat score (out of a possible 200)	179	99	55%

Photo 07. Substrate at Rito de Tierra Amarilla at HWY 112, 10/22/01.

Cumulative Distribution		
Size finer than (mm)	Reference Percent	Study Percent
2	13.1	74.0
2.8	13.1	74.0
4	13.1	74.0
5.6	13.6	74.0
8	15.7	74.0
11.3	18.2	74.0
16	21.7	74.0
22.6	25.3	74.0
32	29.8	77.0
45.3	35.4	80.0
64	47.0	87.0
90.5	61.1	93.0
128	71.2	97.0
181	83.3	99.0
256	90.4	100.0
362	95.5	100.0
512	100.0	100.0
1024	100.0	100.0
2048	100.0	100.0
4096	100.0	100.0



Histogram		
Size finer than (mm)	Reference Percent	Study Percent
2	13.1	74.0
2.8	0.0	0.0
4	0.0	0.0
5.6	0.5	0.0
8	2.0	0.0
11.3	2.5	0.0
16	3.5	0.0
22.6	3.5	0.0
32	4.5	3.0
45.3	5.6	3.0
64	11.6	7.0
90.5	14.1	6.0
128	10.1	4.0
181	12.1	2.0
256	7.1	1.0
362	5.1	0.0
512	4.5	0.0
1024	0.0	0.0
2048	0.0	0.0
4096	0.0	0.0

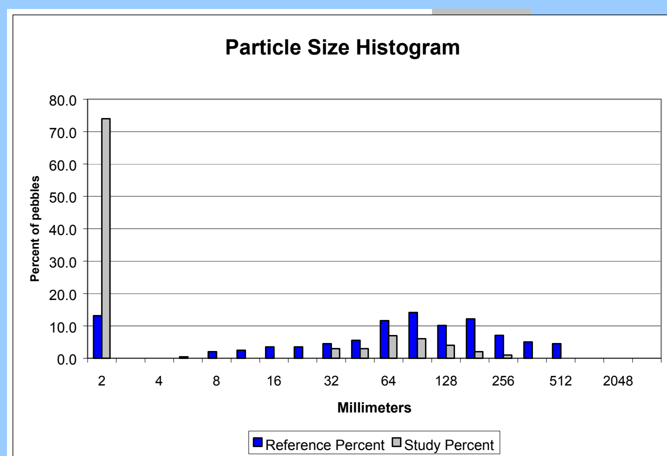


Figure 4.1 Comparison of pebble count data at stations 15 (reference) and 16 (study) (USFS 2001).

Calculations

No calculations were necessary because all loads are specified in percent fines.

The target loads for SBD are show in Table 4.3.

Table 4.3 Calculation of Target Loads for SBD

Location	SBD Standards* (% fines)	SBD Target Load Capacity (% fines)
Rito de Tierra Amarilla	20	20

*This value is based on a narrative standard. The background values for stream bottom deposits were taken from the SBD assessment protocol (SWQB/NMED 2001c).

Measured load was determined by a pebble count as described in the SBD assessment protocol (SWQB/NMED 2001c). Fines are defined as particles less than 2 mm in diameter. Results are displayed in Table 4.4 and Figure 4.1. See Appendix A for field data.

Table 4.4 Calculation of Measured Loads for SBD

Location	SBD (% fines)	SBD Measured Load (% fines)
Rito de Tierra Amarilla	74	74

Waste Load Allocations and Load Allocations

•Waste Load Allocation
There are no point source contributions associated with this TMDL. The waste load allocation (WLA) is zero.

•Load Allocation
In order to calculate the Load Allocation (LA), the WLA and margin of safety (MOS) were subtracted from the target capacity (TMDL) following Equation 2.

Equation 2. $WLA + LA + MOS = TMDL$

The MOS is estimated to be 25% of the target load calculated in Table 4.3. Results are presented in Table 4.5. Additional details on the MOS chosen are presented in section 4.3 below.

Table 4.5 Calculation of TMDL for Stream Bottom Deposits

Location	WLA (% fines)	LA (% fines)	MOS (25%) (% fines)	TMDL (% fines)
Rito de Tierra Amarilla	0	15	5	20

The extensive data collection and analyses necessary to determine background SBD loads for the Rito de Tierra Amarilla watershed was beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background loads.

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the target load allocation (Table 4.3 and 4.5) and the measured load (Table 4.4), and are shown in Table 4.6.

Table 4.6 Calculation of Load Reduction for Stream Bottom Deposits

Location	Load Allocation (% fines)	Measured Load (% fines)	Load Reduction (% fines)
Rito de Tierra Amarilla	15	74	59

Identification and Description of pollutant source(s)

Pollutant sources that could contribute to each segment are listed in Table 4.7.

Table 4.7 Pollutant source summary for Stream Bottom Deposits

Pollutant Sources	**Magnitude** (Load Allocation + MOS)	**Location**	**Potential Sources** (% from each)
Point: None	0	--------	0%
Nonpoint: Stream Bottom Deposits (expressed as percent fines)		Rito de Tierra Amarilla	100% Range Grazing -- Riparian or Upland, Removal of Riparian Vegetation Road Maintenance and Runoff Flow Regulation/Modification Agriculture

Linkage of Water Quality and Pollutant Sources

Where available data are incomplete or where the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

SWQB fieldwork includes an assessment of the potential sources of impairment (SWQB/NMED 1999c). The completed Pollutant Source(s) Documentation Protocol forms in Appendix C provide documentation of a visual analysis of probable sources along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of potential sources of impairment in this watershed. Table 4.7 (Pollutant Source Summary) identifies and quantifies potential sources of nonpoint source impairments along each reach as determined by field reconnaissance and assessment. It is important to consider not only the land directly adjacent to the stream, which is predominantly privately held, but also to consider upland and upstream areas in a more holistic watershed approach to implementing this TMDL.

A substantial and healthy benthic macroinvertebrate community exists at the upper Rito de Tierra Amarilla sampling station (SWQB station 15). An increase in percent fines and consequent reduction in biological score at the lower station (SWQB station 16) results from a number of potential factors. There is a change in soil type and geology from the upper station to the lower station in the valley. The main sources of impairment along this lower reach appear to be from livestock grazing and removal of riparian vegetation in the floodplain upstream of the lower sampling stations. Agricultural practices such as grazing appear to have contributed to the removal of riparian vegetation and streambank destabilization. Field staff observed several horses and cattle while taking measurements at the lower sampling station (Photo 08). There are several small animal confinement pens, irrigation return flows, and poorly designed culverts at road crossings (SWQB/NMED 2001a). The reach flows through Tierra Amarilla in which all the above factors are concentrated (Photo 06). When the area was first settled, creating narrow strips from the road all the way to the stream so each family's livestock would have access to a water source broke up land. In many instances, these plots have been completely cleared of vegetation that would have filtered out sediments before reaching the stream. Direct access of livestock to the stream banks has caused streambank destabilization in many areas.

Photo 08. Rito de Tierra Amarilla upstream of HWY 112, 06/11/02.

The channel appears to have an increased width-to-depth ratio throughout this lower portion of the Rito de Tierra Amarilla as a result of the above-mentioned landuse practices. Given the low valley slope at the lower station (0.0036), the channel should be narrower and deeper which would transport sediment more efficiently (Rosgen 1996). There are also irrigation ditches coming off of the Rito de Tierra Amarilla that at times divert the majority of the flow from the stream. Reductions in flow due to irrigation demands can greatly reduce a stream's ability to efficiently transport sediment. At present, the state of New Mexico does not have an "instream flow" mechanism in place whereby water would be left in a stream bed to be used to protect habitat and water quality for fish, wildlife, recreational, and/or aesthetic uses.

4.3 Margin of Safety (MOS)

TMDLs should reflect a margin of safety based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For this TMDL, there will be no margin of safety for point sources since there are none. However, the margin of safety is estimated to be an addition of **25%** for SBD caused by nonpoint sources, excluding background. This margin of safety incorporates several factors:

•*Errors in calculating NPS loads*

A level of uncertainty exists in the relationship between embeddedness, fines, and biological score. In this case, the percent fines are based on a narrative standard and there are also potential errors in measurement of nonpoint source loads due to equipment accuracy, time of sampling, and other factors. Accordingly, a conservative margin of safety for SBD increases the TMDL by **25%.**

•*Errors in calculating flow*

Flow estimates were not needed for the SBD calculations, thus do not warrant additional MOS.

4.4 Consideration of seasonal variation

Data used in the calculation of this TMDL were collected during the fall which is biological index period SWQB/NMED has determined is the best time to collect benthic macroinvertebrates in New Mexico (SWQB/NMED 2001b). Fall is a critical time in the life cycle stages of benthic macroinvertebrates in New Mexico. Fall is also generally the low-flow period of the mean annual hydrograph in New Mexico when bottom deposits are most likely to settle and cause impairment, after the summer monsoon season but before annual spring runoff. It is assumed that if critical conditions are met during this time, coverage of any potential seasonal variation will also be met.

4.5 Future Growth

Estimations of future growth are not anticipated to lead to a significant increase for SBD that cannot be controlled with best management practice (BMP) implementation in this watershed.